

# **Invinity Energy Systems,** company introduction and case studies

Prepared January 2022



# Invinity Merger Completed April 2020



- Founded in 2013
- Based in North America
- Strong engineering focus



- Founded in 1989
- Based in the UK
- Strong sales focus





# Corporate Overview

ESTABLISHED

# 2020

Merger of redT Energy  
and Avalon Battery

# 14

YEARS OF R&D  
INVESTMENT

Deploying our third  
generation of proven  
technology

# 73

PATENTS

Granted or pending,  
plus trade secrets  
and know how



# 50

PROJECTS

Over 25 MWh  
installed or signed  
on five continents

# 150

EMPLOYEES

We believe to be the  
most experienced  
team in flow batteries

WORLDWIDE  
PRESENCE

Canada  
(Technology/NA hub)  
UK (Technology/Sales)  
US (Sales/Support)  
China (Manufacturing)



# Invinity's Global Operations

 **VANCOUVER/CANADA**  
Design & Manufacturing



 **BAY AREA/US**  
Sales & Support



 **BATHGATE/UK**  
Design & Manufacturing

 **LONDON/UK**  
Sales & IR



 **SUZHOU/CHINA**  
Manufacturing



 **JOHANNESBURG/SA**  
Sales & Support



# Invinity's Customers

## UTILITIES & DEVELOPERS

- T&D cost deferral/avoidance
- Balancing & ancillary services
- Wholesale market trading

## COMMERCIAL & INDUSTRIAL

- Energy cost reduction
- Carbon reduction
- Improved resiliency

## OFF GRID & MICROGRID

- Secure 24/7 renewable power
- Fuel cost reduction
- Carbon emissions reduction



# TECHNOLOGY OVERVIEW



# Why vanadium?

V(V)



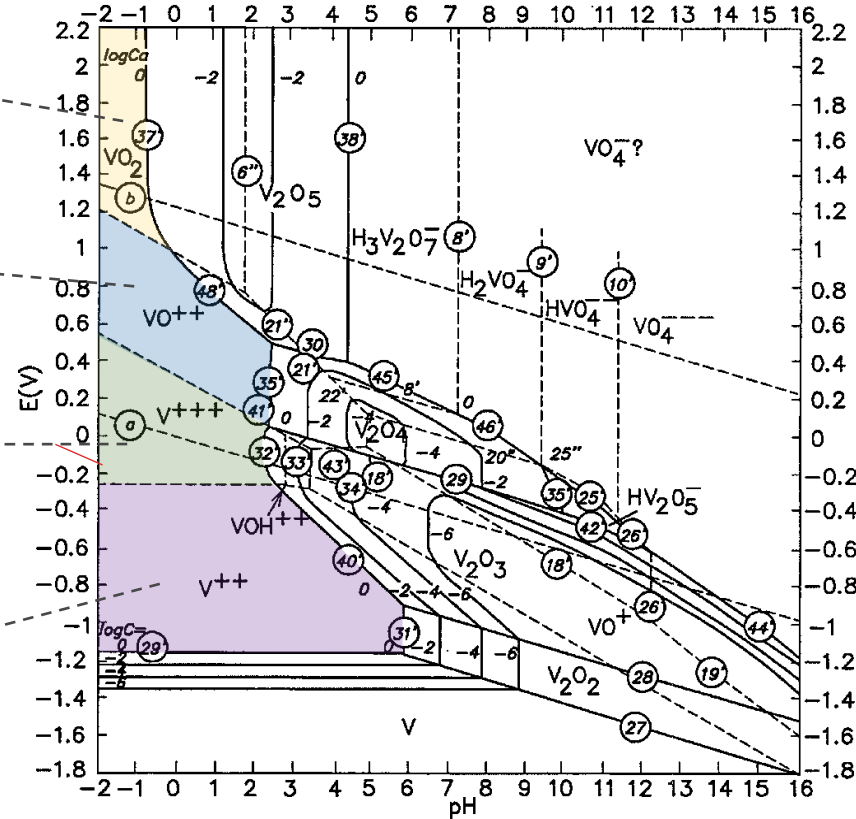
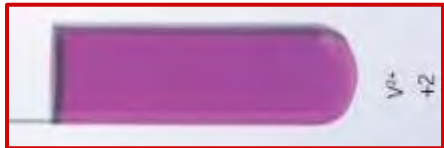
V(IV)



V(III)



V(II)



## VANADIUM

### UNUSUAL CHEMISTRY

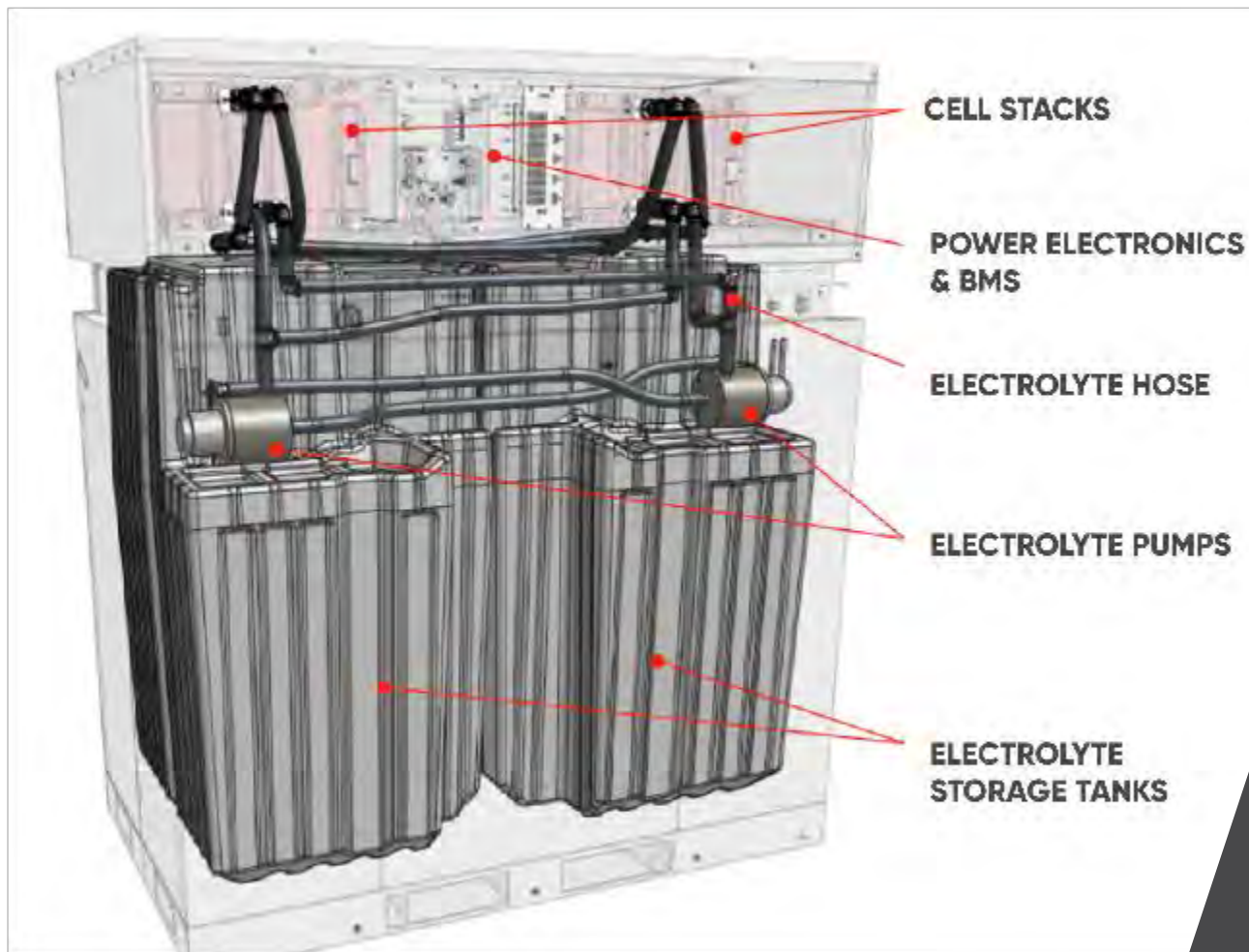
Four oxidation states, soluble to high concentration at the same pH.

Rare phenomenon, essential for single-metal RFB



# Inside a VFB

Safe/Economical/Proven/25+ Year Life



## VANADIUM

### AVAILABLE

Element 23, readily available and more abundant in the Earth's crust than copper. Accessible reserves in Australia, South Africa, United States, Canada, Russia

### REUSABLE

Virtually unlimited working life. 97% proven recovery rate from used electrolyte

### SAFE

Electrolyte is ~70% water, non-flammable with no risk of thermal runaway



# Invinity VS3-022

 **Safe. Long Life.  
Economical. Proven.**



**RATED POWER:  
CONTINUOUS**

**78  
kW**

**ENERGY STORAGE:  
NOMINAL**

**220  
kWh**

**ENERGY STORAGE:  
DURATION**

**2-12  
HOURS**

**LIFETIME:**

**25  
YEARS**

**RECOMMENDED  
DEPTH OF  
DISCHARGE:**

**100%**

**CYCLE LIFE:  
UNLIMITED**



# Roadmap



2015

SMALL SCALE C&I

2018

SMALL SCALE C&I  
SOLAR + STORAGE

2020

DISTRIBUTED GRID ASSETS

2023

CENTRALISED  
GRID ASSETS / 50 MW+



# Invinity VFB Value Proposition



## **SAFER**

Zero risk of thermal runaway  
Exceptional personnel safety



## **COMPELLING ECONOMICS**

Superior levelized cost of storage (LCOS)



## **LONGER LIFE**

Suitable for 25+ years of  
constant cycling



## **PROVEN**

Demonstrated performance in  
commercial applications



## **SUSTAINABLE MATERIALS**

No conflict minerals  
All components easily recyclable



## **FACTORY BUILT**

Standardized product drives  
price down & quality up

**THE RESULT:** Energy storage superior to and complementary with lithium systems.



# INVINITY CASE STUDIES



# Huanghe Hydro

## SOLAR + STORAGE DEPLOYED ON UTILITY-SCALE SITE

- DC-coupled with NEXTracker PV array
- Shifts energy to avoid local grid capacity constraints
- 64 Avalon AFB2.5 units: 320 kW / 1920 kWh
- Commissioned September 2018 in Qinghai, China





# Maharishi International University

## LARGE C&I DEPLOYMENT IN IOWA

- Greater use of self-generated renewable energy to meet climate goals and cut costs
- 1.1. MWh system includes 35 vanadium flow batteries
- Peak shaving and solar shifting strategies
- Project deployed in 2019





# Energy Superhub Oxford



## PROVIDING THE UK'S LARGEST FLOW BATTERY

- Supporting Oxford's decarbonization
- 2 MW / 5 MWh flow battery system
- Flow batteries provide heavy cycling capability
- Order to be fulfilled with 27 Invinity VS3 batteries
- Energised in 2021





# Scottish Water

## DECARBONISING WATER TREATMENT ON ROAD TO NET ZERO

- 0.8 MWh Invinity Battery System + 1 MWp Solar PV
- 4 Invinity VS3s
- 40% reduction in site electricity costs
- 160 tonnes of CO2 avoided each year
- Energised in 2021

By installing energy storage, we can go even further in our use of self-generated renewable power, while also supporting the operation of the wider electricity system.

Donald MacBrayne, Business Development Manager, Scottish Water Horizons



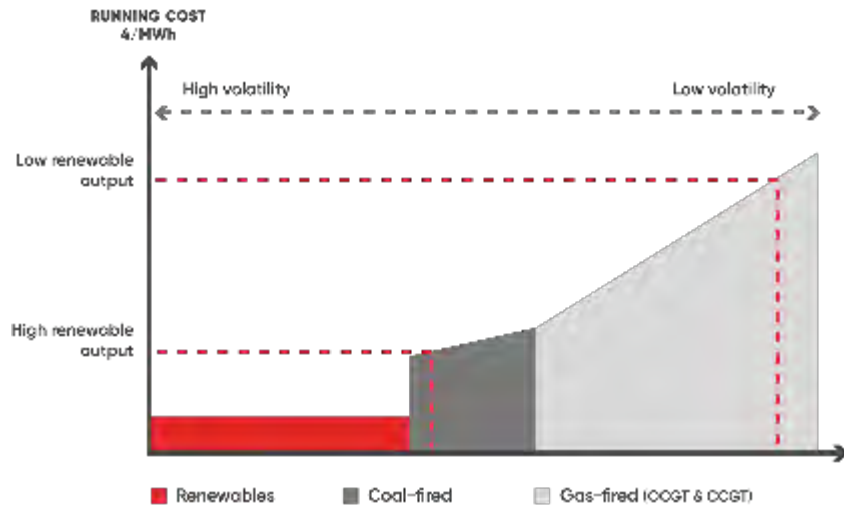


# Yadlamalka Solar + Storage

## WORLD'S LARGEST SOLAR-POWERED VFB

- 8 MWh Invinity Battery System + 6 MWp Solar PV
- Manufacturing starting H1 2021
- 41 Invinity VS3s
- Australia's largest flow battery
- Delivery 2022

### DISPATCHABLE SOLAR TO DISPLACE THERMAL GENERATION

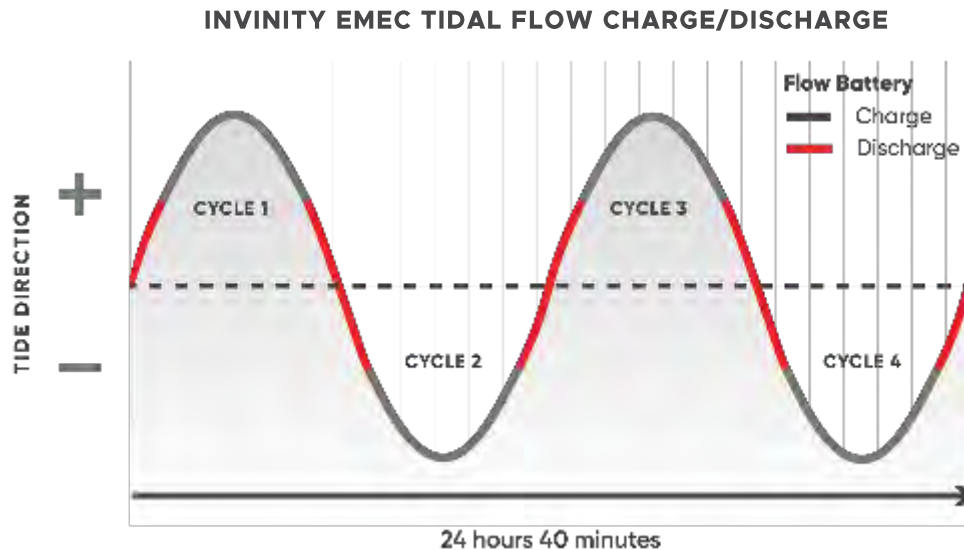




# European Marine Energy Centre

## INVINITY TO DELIVER 1.8 MWH BATTERY SYSTEM

- Tidal power > Invinity energy storage > Hydrogen electrolyser
- To be installed at EMEC in Orkney, Scotland
- Eight Invinity VS3s
- Delivery planned for 2022



Hydrogen and systems integration with renewables will be a key part of our energy transition pathways.

Paul Wheelhouse, Scottish Energy Minister





# Chappice Lake Solar-Storage

## CANADA'S LARGEST VANADIUM FLOW BATTERY

- 8.4 MWh flow battery system + 21 MWp solar array
- Generating clean energy on demand to serve the daily needs of more than 7,000 Albertans
- Order to be fulfilled with 38 Invinity VS3 batteries
- Operational in late 2022





**Safe/Economical/Long-Life/Proven  
Energy Storage**